Wildfire Planning Strategies For Community Design: A Guide For Southeastern Developers And Planners

Authored by:

Robert F. Brzuszek, Assistant Professor
Chris Campany, Assistant Professor
Marc Foster, Graduate Student
Tim Schauwecker, Assistant Professor
Jason Walker, Assistant Professor

Reviewers:

Stephen C. Grado, Professor, Department of Forestry, Mississippi State University
Jim Smalley, National Fire Protection Association

Special thanks to those who have provided valuable information or assistance:

Edward L. Blake, Jr., The Landscape Studio
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1.0 Introduction

Community development is rapidly expanding within many areas of the southeastern United States. Urban centers are being pushed outwards into the surrounding forested and agricultural areas. This zone of new development into rural areas is known as the wildland-urban interface (WUI). The WUI interface has been described as "an area where various structures (most notably private homes) and other human developments meet or are intermingled with forest and other vegetative fuel types" (Kline et al., 2004). Many homeowners often prefer living in wooded landscapes which offer quiet privacy, backyard wildlife, and a direct connection to nature. But with these many benefits comes a few responsibilities to living within the wildland interface, one of which is the occasional risk of wildland fire.

Although dramatic headlines and news footage of significant wildfires in the western United States often captures media attention, the southeast is no stranger to wildfire. The southern pine forest which comprises much of the region is ecologically dependent upon periodic fire. Recent fires in 2007-2008 burned large acreages in Georgia, Virginia, Texas, and South Carolina. The wildfires of 1998 in south central Florida were more extreme, and forced the evacuation of 45,000 people and contributed to the loss of 370 homes and businesses (Florida Division of Emergency Management, 2008). This event changed how cities and developers in Florida design for safer communities from wildfire for residents.

Benefits Of Wildfire Planning For Developers And Planners

Planning for wildfire events is just one part of a comprehensive community planning strategy. Other natural disasters, such as hurricanes, floods, and droughts are not infrequent in the southeastern United States. By proactively designing communities in ways that minimize loss, or providing for more immediate response to these hazards, these developments can be a more sustainable in the face of a natural catastrophe. Comprehensive hazard planning provides other benefits. By creating denser development footprints which reduce urban sprawl, the resulting increase in greenspace provides for more recreational opportunity, wildlife and plant species conservation, enhanced carbon sequestration, and opportunities for the creation of wildfire buffer zones. U.S. EPA Tier II regulations will require new developments ensure that stormwater is not degrading the quality of nearby waterbodies. The provision of greenspace, and its location in community development provides for enhanced water infiltration and water runoff quality, and if managed properly also serves as a wildfire buffer.

Using This Guide

This guide provides information and development considerations for planners and builders within the southeastern United States. While there is a wealth of information already publicly available through Firewise® (Firewise, 2008) and the National Fire Protection Association (NFPA, 2008) concerning architectural standards, landscape and buffer zone requirements, and codes and regulations, there are few publications concerning the organization and placement of land use elements in developments to minimize external ground fire damage. Due to the interaction of fire behavior and severe weather conditions, even with the best of defensible planning measures there is no guarantee of protection from wildfire damage. However, it has been demonstrated in numerous fire events that proper wildfire planning measures have actually saved structures from the impacts of advancing ground fires. Depending upon the location of the community development, weather conditions, topographical features, and surrounding forest fuel load, it is wise to utilize multiple planning strategies to maximize defensible space. This guide provides case studies of fire impacted communities in the southeastern U.S., subdivisions designed with fire safety provisions, and examples of buffer zone strategies that have been effective in various fire events. While many included examples are from the western United States, these land use recommendations are applicable to the southeast region.

2.0 Living with Fire

A persistent issue regarding development in rural areas is the occasional risk of wildfire. Pyne (2001) points out that "we are truly a species touched by fire" and that "every place humans visited they touched with fire." Our ancestors controlled and utilized fire to manipulate their environment and in turn aided the course of human evolution. This use of fire in turn furthered the spread of fire-adapted ecosystems. This anthropogenic fire regime, in competition with lightning-caused fire, remained in place in much of the world until the Enlightenment (Pyne, 2001). In the U.S., by the mid-19th century, the use of fire to manipulate the land decreased as the concerns about conservation became more prevalent (Sorvig, 2001). As a result of this change in philosophy, many landscape level fire regimes were altered. In many cases, the fire-prone (starved) landscapes we see today, including the WUI, resulted from our removing anthropogenic fire and changing the fire regime (Brose et al., 2001). Wildfire risks associated with the WUI are the result of many factors; however, the change in fire regime cannot be over estimated. As the urban, suburban, and rural fringe (exurbs) continue to merge this increases the WUI. This diverse mosaic makes more the potential for wildfire damage. There are many challenges, risks, and rewards associated with development in the WUI. The increased demand of building and inhabitation in these areas is largely spawned from exurban populations seeking a rural woodsy escape (Monroe et al., 2003; Kline et al., 2004). In planning terms, this is concurrent with sprawl. While there is no standard definition of sprawl, the Vermont Forum on Sprawl defines this type of development as "dispersed development outside of compact urban and village centers along highways and in rural countryside."

3.0 Values of Wildfire Planning

The reduction of wildfire risk is a high priority focus for many communities, state and federal agencies across the Nation. As our Nation's urban cores continue to expand outward from populated centers, numbers of homes and subdivisions infringing upon rural and forested areas are rapidly increasing. Seventeen percent of the U.S. population (56.1 million) lives in non-metropolitan areas that comprise 80% of the total land area. The southern states (USDA Forest Service Region 8 is comprised of Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, and Virginia) contain the fastest growing areas in the U.S. and this region is projected to reach 114 million people by the year 2020 (Cordell and Macie, 2002). The population growth of rural southern counties grew by 7.5% in the 1990's, and this trend is projected to rise on average to 11.5%.

As the population demographics in the South continue to change, the use of prescribed fire is anticipated to become more difficult to utilize and will result in heavier fuel buildups (Southern Group of State Foresters, 2003). Forestry and forestry-related industries comprise the major landholdings in the South (214 million acres), and the USDA Forest Service Region 8 leads the Nation in the number of wildland fires that occur each year. In 2006, 48,000 fires burned over 2.6 million acres in the Southern region. Suppression of wildland fires typically fall upon local fire departments. Due to excessive vegetative fuel buildups from changing land use, fragmentation, sprawl, and additional population densities, wildland fire can sometimes exceed the capabilities of local fire resources (Southern Group of State Foresters, 2003).

Additional factors that may compound future wildfire frequency and intensity are rising annual temperatures. The South's climate is directly impacted by Pacific Ocean El Nino and La Nina temperature fluctuations. In the El Nino cycle the southeastern United States is typically warmer and drier, resulting in drier vegetative fuels. As recently shown in the western states, increasing temperatures are responsible for increased duration and intensity of wildfire seasons (Running, 2006). Increasing annual temperatures are projected for the eastern United States.

4.0 Firewise and regulatory wildfire codes

The fire season of 2000 was one of the worst in U.S. history in 50 years, and more than $2 billion in federal funds were spent suppressing wildland fires. As a result, the National Fire Plan was borne in Congress through a FY 2001 Appropriations Act. The Act directed that state and federal agencies address the wildland fire problem through hazardous fuels reduction as well as habitat restoration.

4.1 Firewise

As a result of the National Fire Plan, the National Wildfire Coordinating Group was formed from multiple agencies including the USDA Forest Service, the Department of the Interior, the National Association of State Foresters, the U.S. Fire Administration and the National Fire Protection Association. This interagency group prioritized public education and wildfire awareness with Firewise, a program that offers public workshops, instructional media, and accessible resources for landowners, professional planners, researchers, fire agencies, community leaders, designers, engineers, surveyors and others to minimize fire risks on private and public lands. The Firewise Communities program encourages homeowners and developers to incorporate methods and techniques in both built and undeveloped lands to minimize wildfire damage should it occur. Recommendations developed include land management techniques such as reducing potential fire fuels around residences, maintaining healthy and well irrigated landscapes, selecting plants and building materials that are not fire prone, and incorporating fire breaks and equipment corridors around structures. An extensive library of resources and information on home protection and community programs is available at http://www.firewise.org/.

4.2 Model wildfire code ordinances

Communities are increasingly adopting or strengthening wildland fire ordinances to minimize wildfire damage. The majority of community wildland codes address 1) vegetative fuel clearance around structures, 2) vegetative maintenance, and 3) vehicular access requirements. Primarily, these fire codes and ordinances attempt to reduce damage and the risk of possible injury for homeowners and firefighters in the WUI. Homeowners will better accept community ordinances if there is a high perception of risk and awareness (Gardener et al., 1987). Regulations directed toward development in fire risk areas do not guarantee a community will be free from fire risk, but may reduce the potential for damage. Advantages to implementing wildfire regulations in developments are many, as are the methods for establishing priorities. Wildfire mitigation may occur in the regulations for new and existing developments, in the development review process, in zoning, covenant or deed restrictions, requirements for fuel modification in high risk zones, and building and construction standards. Disadvantages to wildfire regulations include potentially higher construction and maintenance costs for homeowners or associations, resistance to adopting regulations by homeowners, possibility of conflict with existing tree or natural resource ordinances, monitoring, administration and enforcement costs, and lack of guarantees that proper maintenance will be kept in the absence of administration and enforcement.

A methodology on how to develop systems and tools to assess fire hazards was published by the National Wildland/Urban Interface Fire Protection Program in 1997 and revised by the National Firewise Communities Program in 2005 to reflect the relationships between Community Wildfire Protection Plans, Firewise Communities® planning, and hazard reduction considerations for the home ignition zone. This method organizes the hazard assessment process into a series of steps that include: 1) selection of areas to be evaluated, 2) hazard components to be considered in the assessment, 3) ranking of hazard components, and 4) compilation of hazard rankings into a usable format.

4.2.1 NFPA 1144 Standard for Reducing Structure Ignition Hazards from Wildland Fire, 2008 edition

Specific ranking information for landscape and structural features was established through NFPA 1144 Standard for Protecting Life and Property from Wildfire, 2002 edition and previous. Responding to the research and needed focus on preventing WUI disasters in which hundreds of homes are often destroyed or damaged, the NFPA Technical Committee for Forest and Rural Fire Protection revised the document to reflect the approach offered by the National Firewise Communities Program. The new document entitled NFPA 1144 Standard for Reducing Structure Ignition Hazards from Wildland Fire, 2008 edition (National Fire Protection Association, 2008), includes a procedure and details to assess hazards around

existing homes in interface areas and design criteria for new homes. Also included are suggested mitigation measures, based on Firewise concepts that might be offered to residents.

NFPA 1411 Standard for Fire Protection Infrastructure for Land Development in Suburban ands Rural Areas, 2008 edition. Likewise, the NFPA Technical Committee revised this document to include the infrastructure elements from NFPA 1144 (2002 edition) because they recognized that the objective should be preventing ignition of structures and that water supplies, road width, and street signage were suppression issues and have little or nothing to do with preventing ignitions. The standard outlines the essential requirements for land use conversion that results in community design and development, including road widths and emergency vehicle accessibility, water supplies, topography, construction materials, and available fire protection strategies.

4.2.2 The International Urban-Wildland Interface Code™

The International Code Council, Inc. (ICC) produced the International Urban-Wildland Interface Code® in 2003. The ICC is a nonprofit organization dedicated to developing single sets of national model construction codes. This ready to adopt wildland-urban interface code is for municipalities and county jurisdictions and bridges the code requirements of the pre-existing International Building Code® and the International Fire Code®. The document provides for the minimum regulations for land use and development in wildland-urban areas. It covers the administration and authority of government, definitions, special building construction regulations, fire-protection requirements, and general requirements.

4.2.3 Florida codes

While the state of Florida does not have a statewide urban-wildland public law, a model ordinance for local communities has been developed through the Florida Department of Community Affairs (FDCA) and the Florida Department of Agriculture and Consumer Services. Wildfire Mitigation in Florida is a comprehensive document for regional communities on land use planning strategies and best development practices in wildland-urban zones.

Counties and municipalities are required through a Florida Statute (Section 163.3167) to produce a Local Government Comprehensive Plan to guide their future development and growth. The plan gives counties and local governments the power to develop guidelines for a balanced future growth and designate the proposed locations for various land uses. Portions of the statute require protection of wetlands and other natural resources, and encourage the protection of residents from wildfire, hurricane, or other natural disasters; including all necessary features for protection such as development and road standards. However, unless plans are made policy, are reflected in local codes and zoning maps and ordinances, and are administered and enforced they are likely to have little if any real effect in achieving the stated goals and objectives of the plan.

5.0 Wildfire code provisions

The authors have previously examined nationwide municipal and county wildland fire codes containing provisions for landscape features and summarized their general requirements for new or existing development (Brzuszek and Walker, 2008). This research revealed 12 ordinance provisions that fall into four categories of vegetative fuel clearance, building requirements, roadway and driveway standards, and planning and assessment. The following is a discussion of these four elements.

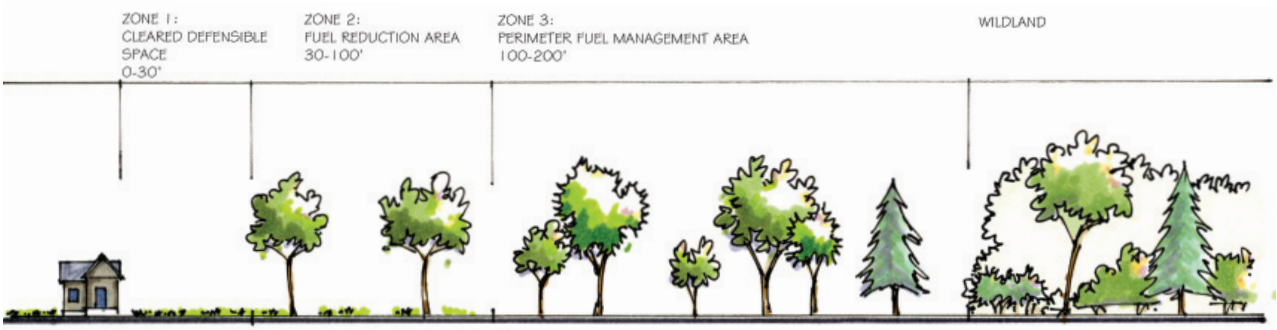

Figure 1. Wildfire mitigation zones around structures include zones of managed vegetation, fuel reduction and transition areas (Illustration redrawn by Marc Foster).

5.1 Vegetative fuel clearance

A major provision of many ordinances concerns the distance between heavy vegetation types and the proposed or existing structures. These distances coincide with what firefighters term "defensible space," that is the space that creates a fire break between fuels (between vegetation and structure) and allows firefighters room to effectively fight an oncoming wildfire. Defensible space usually includes multiple zones for fuel modification, ranging from clearing flammable materials immediately surrounding a residence, to measures to protect zones that surround an entire subdivision. Most codes identify a gradient of two or three zones with unique provisions for the establishment and management of these defensible areas.

The zone immediately adjacent to a dwelling is the area of maximum fuel modification and management, and typically extends 30 feet from the structure. The purpose is to reduce the spread of an external fire by limiting the height or spacing of vegetation. Ultimately this regulation would affect any planting plan. High Fire Hazard Area Landscape Guidelines from the City of Santa Barbara, California are based upon the Uniform Fire Code. The code recommends that in Zone 1 (0-30 feet from structures) "Plants should be low growing, irrigated plants. Focus should be on ground covers not more than 12 inches in height or succulents. Use non-flammable materials for paths, patios, and mulch" (Santa Barbara City Fire Department, 2001). This document also lists plants to remove or avoid using in landscape zones because they are more flammable. These include pampas grass (Cortaderia sp.), cypress (Cupressus sp.), eucalyptus (Eucalyptus sp.), fountain grass (Pennisetum sp.), and pine (Pinus sp.). Many state fire or cooperative agencies offer a recommended Firewise plant list for their area.

The second zone is a transition area to any adjacent woodland. This zone is managed for fuels between the woodland and a structure regardless of property ownership. The extent ranges from 30 to 100 feet; however, in high risk areas the distance may increase beyond 100 feet. In this zone, the edges of tree crowns should typically be separated by 10 feet or more. The 10-foot crown spacing is acceptable on slopes between 0-10%. However, as slope increases, the spacing between tree crowns increases to as much as 30 feet on slopes exceeding 40 % (Eagle County, 2004).

Although ordinances often include these two vegetative modification zones, provisions for the establishment and management of each zone varies. However, the different fuel modification codes share many commonalities including pruning, thinning, and removal of trees, shrubs, and grasses to successfully "fragment" ground and crown fires as they move across a site. Shrubs underneath trees serve as a fire "ladder," where fire spreads into tree crowns from a ground source (e.g., shrubs and low tree branches). Trees may also require pruning (limbing-up) to achieve the same purpose. Additionally, spacing between tree crowns determines the need for pruning or removal to manage a crown fire. Most codes set a minimum distance between tree crowns, usually measured from the edge of the crown to branches of adjacent trees.

In conjunction with codes regulating vegetation fuel clearance, vegetative maintenance is critical for managing dangerous fuel loads in high

fire risk areas. Analysis of codes revealed that vegetation maintenance is required in 49.4% of all ordinances reviewed. These require on-going fuel load management to ensure that fuel does not substantially increase over time, and thus heighten the risk of an unmanageable wildfire. Many ordinances and codes, such as the California Public Resource Code 4291 (CA PRC, 2005), stipulate that the property owner or manager is responsible for maintenance of vegetative fuel zones. Infractions are enforced by assessing penalties or fines.

5.2 Roadway and driveway standards

In the last decade, fires such as the Laguna Beach and Malibu (California) fires "have placed firefighters in dangerous situations as a result of inadequate planning and design of roadways, signs, water supplies, and other infrastructure considerations" (NFPA, 2005). In response, many municipalities and counties have adopted requirements for roadway and driveway planning and design in WUI areas.

These standards ensure access for large emergency vehicles by stipulating minimum road/drive widths, minimum vertical clearance, an appropriate surface material, maximum grade, turnaround distances and radii, street identification, and premise identification. Among the codes reviewed, roadway widths ranged from a minimum of 18 to 25 feet, with a range of 13.5 to15 feet vertical clearance for access roads. Minimum widths ranged from 10 to 12 feet with a vertical clearance of 13.5 to 16 feet. The most common driveway standard was 12 feet in width with a vertical clearance of 13 feet.

Figure 2. Suggested example of minimum driveway dimensions. (Illustration redrawn by Marc Foster, Pima County, 2006).

5.3 Building requirements

Most building codes in wildfire areas require that roofs, exterior materials, and appendages and projections from residential structures do not serve as a primary source of fuel. Typically, the regulations mandate the use of one-hour-fire-rated resistive materials and include other provisions to protect the entire appendage including the

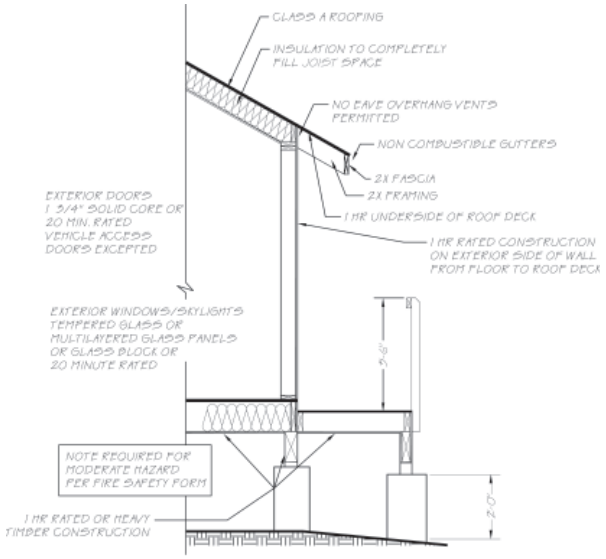

Figure 3. Suggested example of ignition resistant construction (Illustration redrawn by Jeremy N. Murdock, Pima County, 2006).

under-floor space. The under-floor space is most vulnerable from ground fire, and it may often be left unenclosed. If the deck overhangs a descending slope, the under-floor space must be enclosed with fire resistant materials and construction.

Standards requiring property line setbacks for new construction are not as common in wildland fire codes. Their primary purpose is to ensure adequate, "minimal" defensible space around a residential structure. The most common setback distance from property lines is 30 feet, consistent with dimensions for Zone One for defensible space in most ordinances. In fact, in most cases, the standard defensible space requirements make minimum setback distances unnecessary or redundant. Setbacks may also allow space for future expansion of roadways, and for "having adequate alignment, dimensions, and vision clearance" along roadways (Lassen County, 1962).

5.4 Planning and assessment

Greenbelts are essentially an extension of defensible space with the primary difference being scale. While defensible space often refers to zones within a single property boundary, greenbelts are usually part of a development plan for subdivisions or developments. Greenbelts separate wildland fuels and inhabitable structures. Locating greenbelts involves a thorough understanding of the site and fire behavior, and they must be strategically located to aid in preventing a wildfire from spreading into a residential area. When the area around a single property cannot ensure adequate defensible space, due to a site constraint such as steep topography, requiring a greenbelt is particularly justified. Greenbelts also provide the community with open space for recreation. They might include golf courses, parks, and playgrounds.

Typically, hazard assements are only required for proposed developments or subdivisions. In the wildfire hazard areas identified, the assessment report must prove that the developer adequately met criteria for reducing or eliminating wildfire hazards at the time of initial development. In most cases, a qualified professional forester must prepare these plans or reports. State and local planning authorities may also have to address conflicting requirements between “firewise” requirements and conservation provisions in codes and laws, such as forest retention requirements.

Figure 4. Example of a managed greenbelt area (Photo: Bob Brzuszek).

6.0 Case studies of Florida wildfire problems in developments

Protection from wildfire was just one part of an overall regional natural hazard strategy. There was an opportunity for planners to better understand their role in a WUI fire by examining a few case studies of fire damaged communities. Whether planners and builders were involved in the original planning process for these communities or for individual residences; conclusions generated by investigations into these catastrophic events point to areas that planners can best contribute their expertise. The following case studies center on the 1998 Florida wildfires in Flagler, Volusia, and Brevard Counties, with descriptions of how they met community edges.

Florida East Coast Fires 1998

Overview:

In late June 1998 several wildfires began in the area inland of Florida's east coast. These fires spread east rapidly, powered by frontal circulation winds and assisted by unseasonably dry conditions resulting from the El Nino oscillation. The fires began to rapidly spread toward the populated East Coast on July 1, crossing multiple road rights of way in excess of 100 feet. The advance continued until July 4, when increased humidity and decreased winds slowed the fires' advance. Rainfall began on July 5 and the fires were brought under control. The final wrap-up work of fully extinguishing the fires took another two weeks.

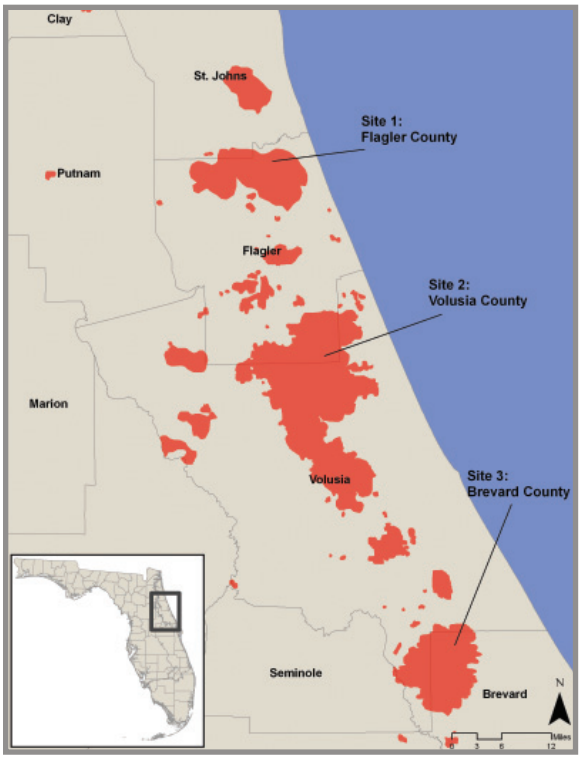

Figure 5. Overview of primary concentration of east coast fires, with selection of three case study fire sites affecting residential areas.

6.1 Site 1: Flagler County Fire

Overview:

This fire began in rural Flagler County in late June and spread east, powered by frontal circulation winds. Over a period of approximately two weeks, the fire spread approximately 14 miles and affected over 41,500 acres. Almost 94% of this area was in Flagler County, with the remainder of the fire extending northwards into southern St. Johns County. Fifty-one buildings were destroyed by the fire, with more than 45,000 residents temporarily displaced during a mandatory evacuation on July 3.

General Landscape Patterns:

The western two-thirds of Site 1 is a mix of upland and wetland forest, with small amounts of cleared or developed areas. Transportation infrastructure was very limited and there was a large roadless area directly west of Palm Coast, between the city and San Mateos. The fire began near the western edge of this roadless area and burned eastwards for up to 10 miles before major roadways and the outskirts of Palm Coast were reached.

There was a network of wetland forests between the starting point for this site and Palm Coast. These wetlands were long, narrow features oriented north-south, perpendicular to the direction of fire travel.

Defensible zones and controls:

The fire crossed four major defensible zones: a 270-foot rights of way, a 180-foot rights of way, the 130-foot U.S. Highway 1 rights of way, and the 180-foot Interstate 95 corridor. Additionally, many other smaller roads, a railway and other potential defensible zones were crossed both before and after the fire entered the populated portion of Flagler County.

Zone Name	Width	Surface	Mobility	Fire Travel
Utility rights of way	270 feet	Grass/Herbaceous	Cleared off-road	10-13 miles beyond
Utility rights of way	180 feet	Grass/Herbaceous	Cleared off-road	8-10 miles beyond
I-95	180 feet	Paved	Roads	2-4 miles beyond
US-1	130 feet	Paved	Roads	0-1.4 miles beyond

Successful defense was implemented along portions of the I-95 corridor, in residential subdivision areas which had implemented fuel reduction controls, and along smaller roadways in areas with relatively more dense (greater than 2 units/acre) development.

Correlating factors relative to successful fire defense:

1. Successful fire defense occurred at or near areas of transition from low-density residential /suburban type land-use patterns to medium and higher-density development.
2. Presence of marsh (emergent wetland types) and open water were associated with fire boundaries. This was in contrast to forested wetland types (see Non-correlating factors below).
3. Increased road density was associated with fire boundaries.

Non-correlating factors to successful fire defense:

1. Low-density residential/suburban areas adjacent to forest areas were often not successfully defended. The majority of this type of area was residential development adjacent to the large roadless areas mentioned above. Lower-density development suffered greater exposure to and damage from fire.
2. The presence of forested wetlands was not associated with successful fire defense. There are multiple lines of forested wetlands crossing the site. The majority of these run perpendicular to the vectors of fire movement. It appeared that forested wetland areas in drought conditions are not effective as defensible zones or slowing/fragmenting influences relative to wildfire travel.
3. The presence of scrub areas was also not associated with successful fire defense. There are few areas mapped as scrub within this site. Scrub accounts for only approximately 2% of the total site area, with no areas larger than 80 acres.
4. Single, large defensible zones were often breached by this fire. The largest defensible zones within Site 1 were all crossed. In the case of the I-95 and US-1 zones, the fire traveled substantial (> 1 mile) average distance after crossing these zones and moving into new territory.

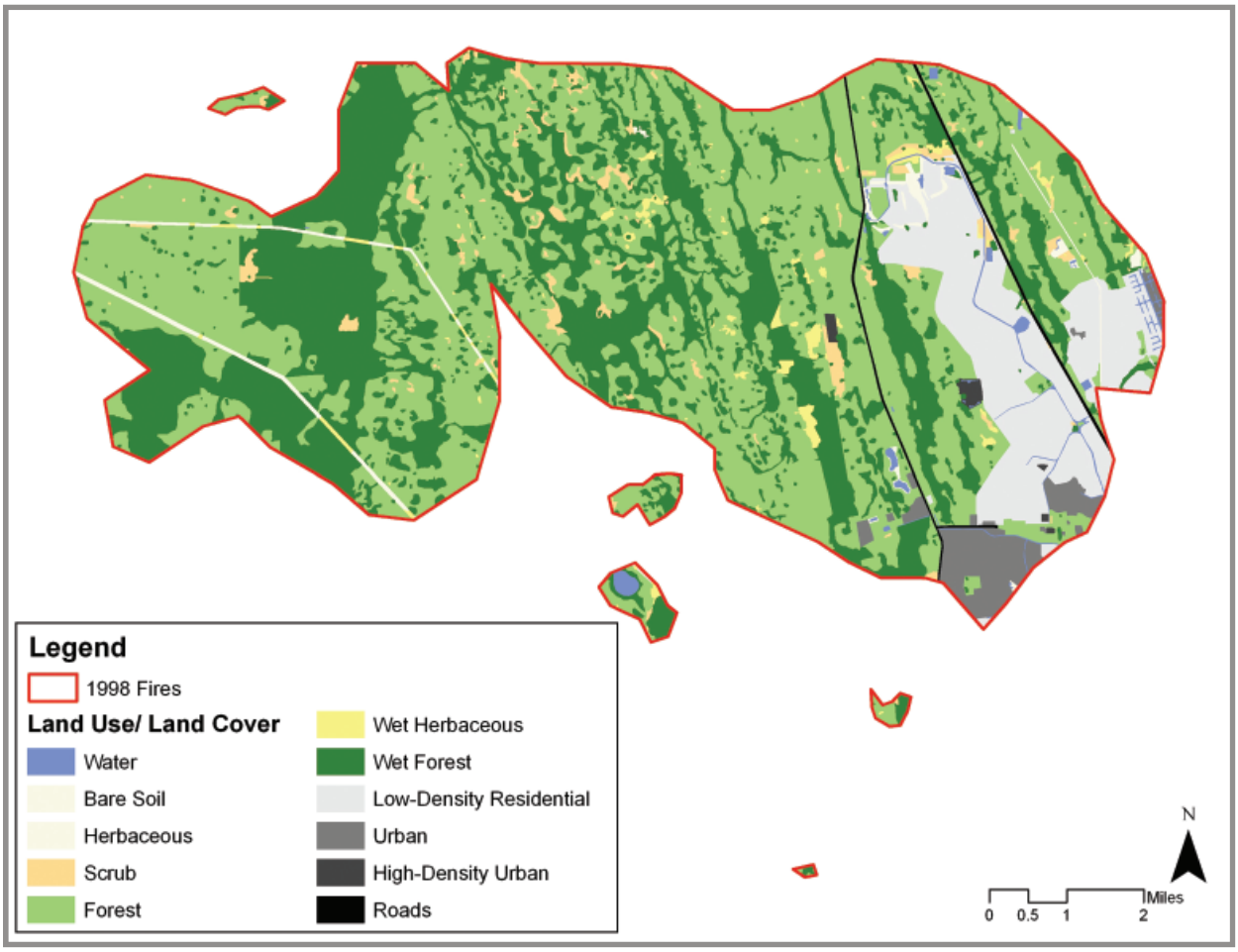

Figure 6: Case study site 1: Flagler/ St. Johns Counties fire. 1995 land use/ land cover data grouped into categories by Florida Land Use, Land Cover Classification System (FLUCCS) codes.

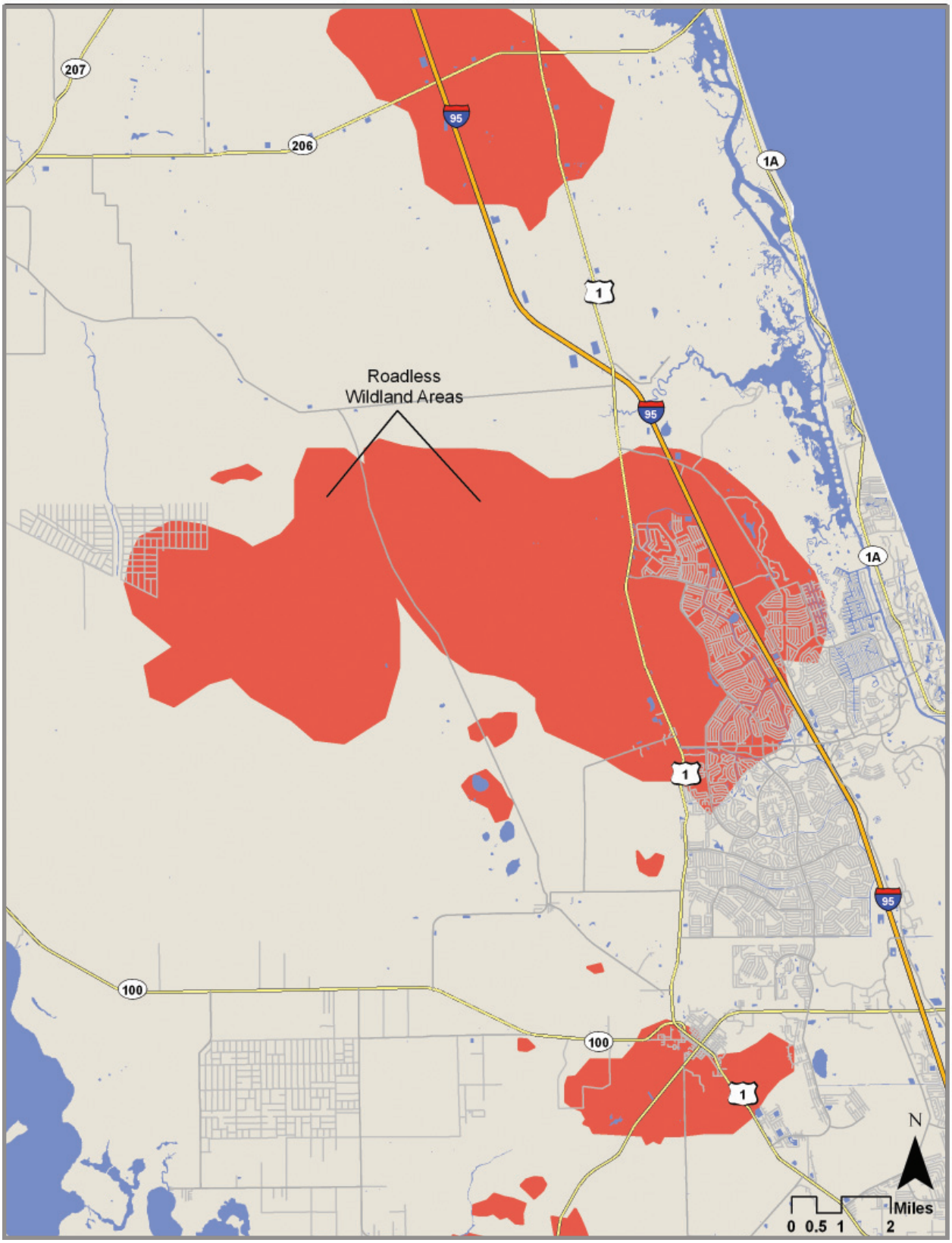

Figure 7: Roadless areas where Site 1 fire developed prior to affecting the Palm Coast community.

6.2 Site 2: Volusia County Fire

Overview:

This fire spread along an almost 26-mile north-south length of Volusia and Flagler Counties. The east-west width of the affected area ranged from approximately 2.5 miles at the narrowest point to 17 miles at the widest expanse. Over 122,000 acres of land were affected. Over 77% of this area was in Volusia County, with the remainder of the fire extending northwards into southern Flagler County.

General landscape patterns:

As with Site 1, the fires began in wildlands to the west of the developed coastline area. Large, virtually roadless areas to the west of Ormond Beach and Daytona Beach were affected first by fire, which traveled east as it burned through a mixture of upland forests with some areas of scrub and forested wetlands. Almost the entirety of Site 2 is forested area with no major north-south roadways and only 3 east-west roadways along the long axis of this site. The fire began near the western edge of this roadless area and burned eastwards for 7-12 miles before major roadways and the outskirts of Ormond Beach were reached.

Defensible zones and controls:

The fire crossed three major defensible zones: a 300-foot utility rights of way, a 200-foot utility rights of way, and the 180-foot Interstate 95 corridor. Few other potential defensible zones were crossed after the fire entered the populated portion of this site. Approximately 5000 acres were burned on the east side of the I-95 corridor.

Successful defense was implemented in wildland areas near I-4, along and near the I-95 and US-1 corridors, and along smaller roadways in areas with low-density (less than 2 units/ acre) development.

Correlating factors relative to successful fire defense:

1. The interface area between forested and low-density residential development was relatively successfully defended in this fire event. Areas where the wildland interface was adjacent to other higher-density urban development were also successfully defended.
2. Large roads were used successfully as defensible zones. Fire travel was very limited beyond the I-95 corridor and the width of the burn path was substantially reduced.
3. Density of east-west roadways. The narrowest area of east-west burn travel is where US-92 and I-4 converge and are approximately 2-3 miles apart. Burn area limits end abruptly even in the middle of forested areas in this portion of the site and do not extend to near developed areas.
4. Increased road density, including smaller neighborhood roads was associated with fire boundaries. Denser transportation networks allow for more precise positioning and fallback zones for fire control personnel.

Non-correlating factors relative to successful fire defense:

1. As with Site 1, areas of transition from forest to low-density residential/suburban type land-use pattern were not very successfully defended.
2. The Tomoka River and associated bottomlands. These riverine open-water areas and forests were crossed by the fire and the burn area extended up to 2.5 miles beyond.
3. Presence of forested wetlands. There are multiple areas of forested wetlands across the site. Many of these are

Zone Name	Width	Surface	Mobility	Fire Travel
Electric Power Line	300 feet	Grass/Herbaceous	Cleared off-road	2.5-10 miles beyond
Electric Power Line	200 feet	Grass/Herbaceous	Cleared off-road	0.3-3 miles beyond
I-95	180 feet	Paved	Roads	0.3-1.8 miles beyond

large irregularly shaped features in contrast to the predominantly long, narrow features in Site 1. It appeared that forested wetland areas were not effective in drought periods as defensible zones or slowing/ fragmenting influences relative to wildfire travel in this instance. The drought conditions present at the time of this fire may have reduced the any effects the wetlands would have had on mitigating fire damage and advance.

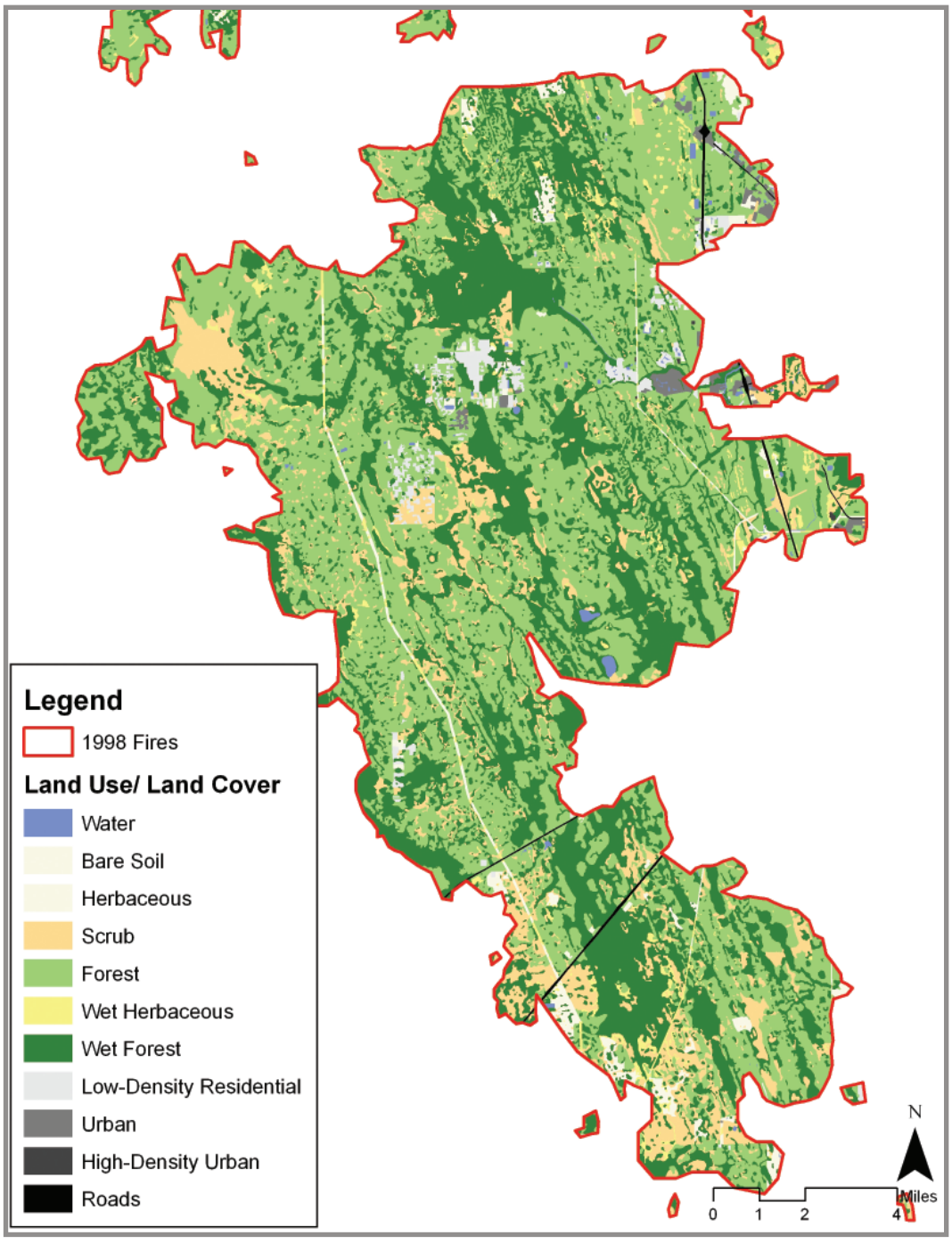

Figure 8: Case study site 2, Volusia County fire : 1995 land use/ land cover data grouped into categories by FLUCCS codes.

6.3 Site 3: Brevard County Fire

Overview:

This fire spread affected a roughly circular area 8 to 10 miles across at the corner of Brevard, Volusia and Seminole Counties. Over 45,000 acres of land were affected. Almost two-thirds of this area was in Brevard County, 33.3% was in Volusia County, and the remaining 0.7% affected Seminole County. A total of 36 residences were impacted.

General landscape patterns:

Like the previous two sites, the fires began in wildlands to the west of the developed coastline area. In this case, the initial affected area was near Lake Harney and was largely comprised of scrub and freshwater marsh areas. As the fire moved east away from the lake and toward the coast there was less marsh and more forest area. Residential areas were affected from near the beginning near Pennichaw in the northwest corner of the site. After moving east from Pennichaw and Lake Harney, there was a large, roadless area extending approximately 6 miles to the I-95 corridor. There was no major north-south or east-west roadways west of I-95 in this site.

Defensible zones and controls:

The fire crossed three major defensible zones: a 160-foot utility rights of way, the 180-foot I-95 corridor, and two small (< 1 mile each) sections of the 100-foot US Highway 1 corridor. Few other potential defensible zones were crossed after the fire reached the I-95 corridor, with only approximately 3000 acres affected on the east side of the I-95 corridor.

Successful defense was implemented along much of the I-95 corridor, along the US-1 corridor in some areas where I-95 was crossed, and in residential subdivision areas, primarily along smaller roadways in areas with relatively less dense (less than 2 units/ acre) development.

Correlating factors relative to successful fire defense:

1. The interface area between forested and low-density residential development was relatively successfully defended in this fire event. Areas where the wildland interface was adjacent to other higher-density urban development were also successfully defended. Large roads were used successfully as defensible zones. Fire travel was very limited beyond the I-95 corridor and the width of the burn path was substantially reduced.
2. Successful defense occurred in areas with increased density of larger roads. Large defensible zones in sequence may have allowed for more effective fire control. In this case the I-95 and US-1 corridors are within 2 miles of each other.
3. There was successful fire defense near waterways and forested wetlands. There is a ditch and wetland system immediately west of the I-95 corridor in the northern half of this site. This may have played a role in the successful defense of this site at and near this area.

Non-correlating factors relative to successful fire defense:

1. Heavy mixing of scrub and low-density residential land-use patterns. The fire ended in areas where low-density subdivision development is immediately adjacent to scrub areas. Very little of this type of land use mixture burned once the fire crossed I-95.
2. There was substantial road access and residential areas near the fire's beginning point near Pennichaw. Despite the fire's accessibility in its early stages, it was not extinguished near the point of origin.

Zone Name	Width	Surface	Mobility	Fire Travel
Electric Power Line	160 feet	Grass/Herbaceous	Cleared off-road	0.5-4.5 miles beyond
I-95	180 feet	Paved	Roads	0.2-1.3 miles beyond
US-1	100 feet	Paved	Roads	0.3 miles beyond

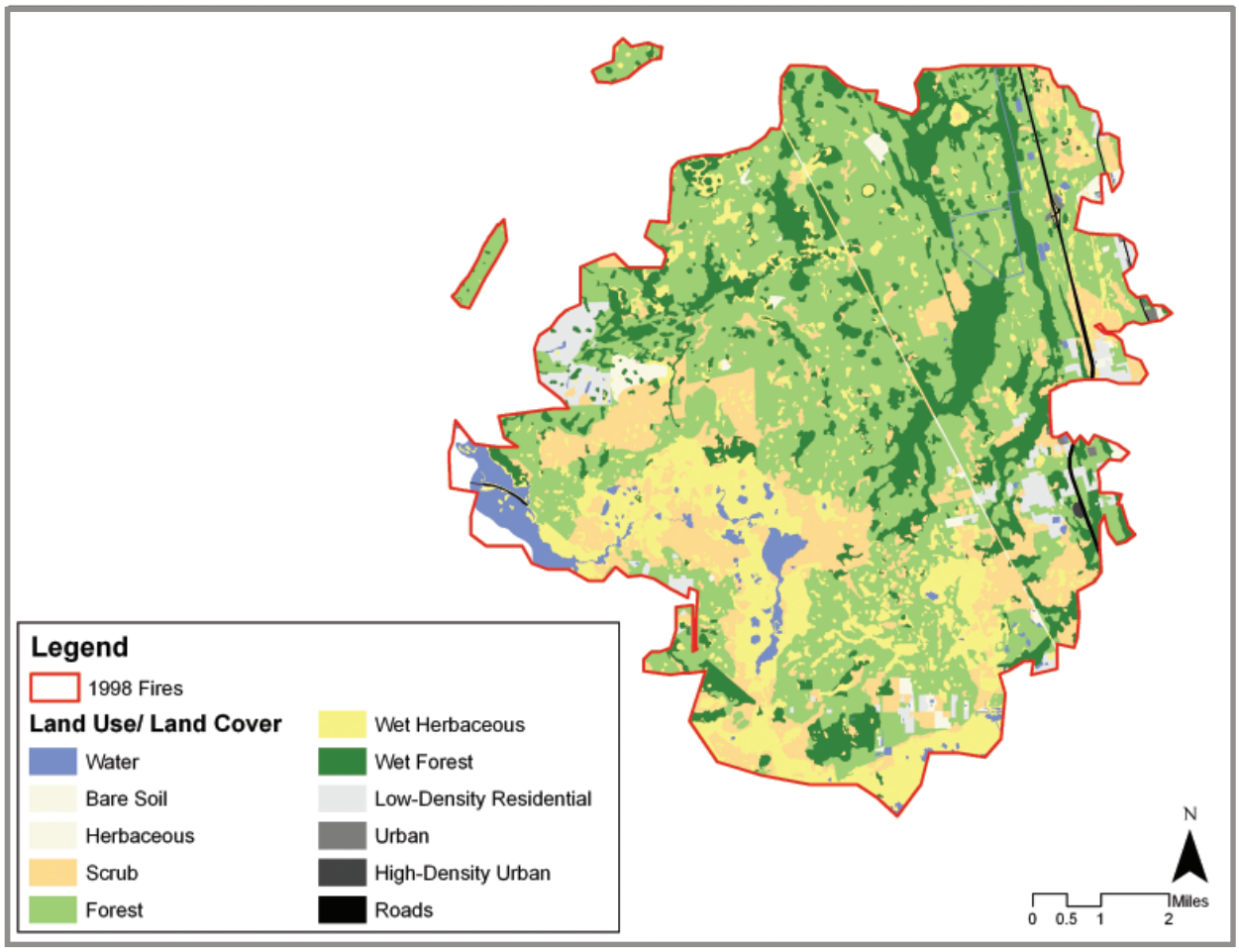

Figure 9 : Case study site 3, Brevard County fire : 1995 land use/ land cover data grouped into categories by FLUCCS codes.

6.4 Summary of Key Conditions and Design Implications of 1998 Florida East Coast Fires

Some key characteristics of the 1998 fires:

1. Severe drought conditions resulting from El Nino Severe drought conditions resulting from El Nino weather patterns. The drought resulted in dry summer thunderstorms with lightning and no rain. Higher than average westerly winds resulting from periodic frontal passage.
2. Ample fuel loads in adjacent wildlands. Typically humidity and precipitation levels are high enough to minimize fire risk in these areas, so fuel management and reduction for these areas was minimal.
3. Weather, fuel and landscape pattern combined to form an excellent environment for firebrand transport and high-intensity fire. Huge areas of dry pine forests to the west, low-density residential development to the east and strong west winds combined to create very intense fires burning through miles of uninterrupted forest then abruptly meeting residential development.
4. Major roads (I-95 and US-1) were crossed, as well as large power line rights of way and many smaller roads.

Conditions supported fires crossing large (100-200 feet wide) road rights of way and cleared utility easements up to 300 feet in width, in addition to covering up to 17 miles of sequential burn distance. The scale of these events was so large that they cannot be fully addressed at the scale of a single subdivision or community. Larger, landscape-level patterns appeared to offer some consistent factors and point toward site-selection and large-scale regional planning as key factors in disaster mitigation under extreme circumstances.

Suggestions for design considerations:

1. Proximity of potential fuel sources, fire-prone habitat types and roadless areas are risk factors in siting communities. All three fires examined had tens of thousands of forested, relatively roadless wildlands adjacent to the sites of affected residential developments. This landscape-level position had a substantial effect on the fire risk of much smaller-scale subdivisions. Examination of fire risk at multiple scales may inform site selection and design processes at the community or subdivision scale. The identification of risk can also inform the planning decisions as to what areas are appropriate for residential development when creating comprehensive plans, zoning ordinances and other codes, and zoning maps. This information can also inform local planning decisions as to what development patterns (i.e. dispersed versus clustered or more compact development) are most defensible and resilient.
2. Weather patterns leading to wildfire events may be very different than prevailing seasonal conditions. Periodic weather patterns, especially those associated with higher-intensity winds need to be examined to determine where exposure to fire risk is the greatest. All three fires examined were affected and driven eastwards toward populated areas by frontal passage winds, rather than normal prevailing winds from the south to southeast.
3. Multiple, smaller defensible zones may provide the best defense in an intense fire event with severe weather conditions. The largest available defensible zones were crossed in all three of the examined fires, while successful defense was mounted in smaller, residential road and open space networks in subdivisions in Flagler, Volusia and Brevard Counties.
4. Wetlands may not necessarily make a difference. Forested wetlands burned in drought conditions and appear to have carried the fire as quickly as upland forests. All fire areas examined had bands of forested wetlands running perpendicular to the direction of fire travel. These wetlands were not the points of origin for the fires, but were crossed after the fires had built some intensity in drier areas. Open marsh areas may serve as a more effective barrier than wooded wetland types, and the possibility exists for converting wetlands intended as fire barriers from forested to open-canopy or canopy-less habitats immediately adjoining existing structures. Local plans and codes should address the appropriateness of allowing development within, or immediately adjacent to, wooded wetlands.

5. Use cleared easements and rights of way when possible. During the 1998 fires, these areas contributed to successful defense in many areas. Utility easements can provide hundreds of feet of canopy-free space that can be used for perimeter fire defense. Vehicle accessibility is often problematic on these easements, so measures taken to improve access and manage sapling and shrub growth can enhance their effectiveness in fire defense.
6. Incorporate water or emergent wetland features where possible. Canal, river and marsh networks all contributed to successful fire defense in both the Flagler and Brevard County sites. Marsh environments can be built as stormwater controls or created from forested wetlands by canopy reduction. Features having the greatest effect in the 1998 fires were oriented north-south, perpendicular to the direction of fire travel.

7.0 Smart Growth/Low Impact Development

The American Planning Association's Growing Smart℠ project recommended that wildfire planning in communities should be part of a larger natural hazards plan that identifies all potential hazards including flooding, wind, storms, or geological conditions (Schwab et al., 2005). In comprehensive community planning, incorporating defensive wildfire measures such as the use and strategic placement of greenbelts that may involve parks, boulevards, playgrounds, recreational or storm retention waterbodies, or golf courses to provide larger measures of protection. Similarly, the location of roadways of sufficient size to accommodate emergency vehicles may also serve as fuel breaks. Proper planning will include multiple egress routes that can be used during emergencies. As Monroe (2002) noted, these planning measures may be difficult to incorporate in established areas or not even considered in the planning phases. By understanding these planning elements as defensible space, planners can better integrate community needs with fire safety. Ultimately, plans should address the fundamental question as to whether or not it is in the interest of public health, safety and welfare to allow further development within fire prone ecosystems, just as plans should address development in areas prone to other highly-predictable risks such as flooding, earthquakes, or landslides.

There are many benefits to comprehensive community planning which include:

- Allowing for an understanding of existing physical, environmental and social conditions.
- Encouraging inventorying and protection of important natural and cultural resources.
- Identifying the potential hazards or limitations for development in certain areas, including wildfire hazards.
- Allowing for future growth projections and infrastructure needs.
- Providing for priorities in the planning and implementation issues of a region.
- Allowing for community input and discussion.
- Balancing multiple planning activities including transportation needs, utilities and management, and economic growth.
- Providing the legal basis for land use recommendations, hazard identification, and local ordinances and policies, and monitoring and enforcement programs.

Many communities across the Nation are concerned about continuation of sprawl growth patterns into rural areas, loss of agricultural and forest land, and wildfire risks in the WUI. While still providing for stronger economic and population growth, concentrating infill development in existing community footprints maximizes current transportation and utility infrastructures, housing opportunities and choices; provides for alternative transportation methods, mixed use development, and revitalized economic stimulus. In essence, these are the principles of Smart Growth. Smart Growth is a comprehensive planning guide that utilizes redevelopment in existing urbanized areas and reduces growth in rural or newly urbanizing lands (American Planning Association, 2002).

Smart Growth utilizes compact building design patterns that reduce the footprint of new construction and impermeable surfaces, allowing developments to preserve more green space. Encouraging the mixed use of taller buildings on less land requires less land for construction and provides cost savings for maintaining roads and other utility infrastructure. The benefits of conserving green space in residential and commercial landscapes are many, and include:

- allowing rain water, building and parking runoff to infiltrate into the ground reducing

flooding and stormwater drainage needs
- filtering sedimentation and nutrients from runoff reducing water pollution
- providing better opportunities for food, travel and habitat for wildlife species
- providing aesthetic and recreation opportunities for developments
- buffering wind, sun or other climactic effects

States are required by the U.S. Environmental Protection Agency to maintain water quality standards for waters within their jurisdictions under the Federal Water Pollution Control Act. The Water Management Division of Region 4 (southeastern states) utilizes a watershed approach to manage programs. A watershed approach is a framework for management that promotes public and private sector efforts to address priority problems within hydrologically-defined geographic areas, taking into consideration both ground and surface water flow. The Region 4 Water Management Division recognizes the Southeast as a quickly developing area, and recommends sustainable and green infrastructure programs to maintain water quality. Green infrastructure encourages the preservation of existing forests, floodplains and wetlands in developments, as well as agricultural lands. In developed areas, green infrastructure practices to preserve water quality include the implementation of rain gardens, porous pavements, green roofs, infiltration planters, tree boxes, and rainwater harvesting.

In addition to slowing water runoff to allow for better soil infiltration, vegetative buffers also remove pollutants such as soil sediments and excess nutrients (Bolund and Hunhammer, 1999, DeFries et al., 2004). Studies in Pennsylvania have shown that a 6 meter buffer (20 feet) planted in oats can remove 76% of the soil sediments from runoff (Hellmund and Smith, 2006). Similarly, grasslands are effective at nitrogen sequestering, with 24 foot wide vegetative buffers removing 28% excess nitrogen (Bedard-Haughn et al., 2004). Grassland buffers have less vegetative fuel loads than woodland or shrub vegetation types, and cause less severe wildfire control risks. For example, control burns (back burns) are easier to manage than woodland or scrub types.

Utilizing Smart Growth practices to reduce the impervious footprint of developments while conserving green space allows developments to better manage and treat their urban runoff. The preservation and conservation of green space also provides opportunities to create effective wildfire buffers around developments. Combining green space needs for water quality and fire protection is an easy fit. The outer edge of properties is a critical boundary of the WUI.

8.0 Defensive Land Uses for the Outer Edge

There are three primary categories of how development meets the WUI: 1) the boundary, 2) the intermix, and 3) the island (Schwab and Meck, 2005). These terms refer to the density of building layouts and how they meet woodland fuel types. The boundary refers to a clearly defined development, such as a subdivision, with a dense internal clustering and whose outer edges are adjacent a woodland fuel type. Intermix occurs when structures are scattered intermittently within woodland areas. These isolated properties are preferred by residents who wish to 'be in nature' and offer the most challenges for wildfire protection. An island refers to remnant woodland areas that are bounded and left within a larger developed community, such as a woodlot or natural area within an urban environment.

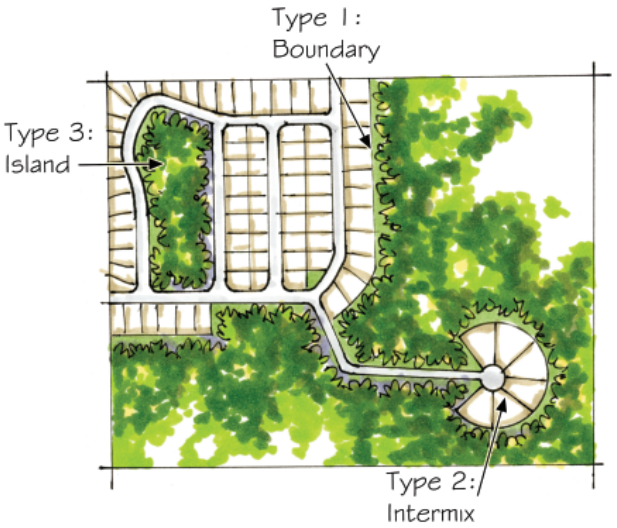

Figure 10. Categories of the wildland-urban interface (Illustration redrawn by Marc Foster, Florida Department of Community Affairs, 2004).

8.1. Greenbelts

Vegetative fuel clearance is the most common management method of creating defensible wildfire barriers. California requires a minimum of 30 feet of managed vegetative fuels from any structure (CA PRC 4291, 2005). For high fire hazard areas, 100 to 200 feet of managed vegetation may be required. Both NFPA 1144 and UWI codes include language for the creation of defensible vegetative zones (NFPA 1144, 2005; ICC, 2003). It should be noted that when such requirements are applied to individual structures within new developments the regulations have the potential to inflate lot size and further exacerbate sprawl. The promotion of compact development patterns that result in buffers around defensible neighborhoods is a better approach not only in terms of reducing sprawl, but also the facilitation of fire defenses as human resources will not have to be scattered to defend myriad stand alone dwellings and other structures. While these codes account for individual structure protection and subdivision standards including minimum road widths for emergency vehicle access, there are relatively few regulatory codes enacted for entire development standards. Although these are general recommended widths, provision for maximum defensible space and multiple protection strategies are best. Severe wildfires under windy conditions have been known to jump fuel clearance zones exceeding 200 feet wide, or may create 'spot' fires, which are burning embers carried by winds across fuel breaks.

Providing greenbelts at the outer edges of developments have been shown to be effective in preventing or slowing advancing groundfires. Greenbelts are managed vegetated buffer zones between developments and the WUI. The use of greenbelts or parks for fire control is well established, as evidenced in the early 20th century developments of Delaney Park Strip in Anchorage, Alaska; or Hogans Creek parks in Jacksonville, Florida. Greenbelts may include a variety of land uses including ballfield areas, walking trails, golf courses, pastures, parks, cemeteries, reservoirs, agricultural land, and other land uses. These managed lands should be considered in areas that abut forest lands or primary areas from which wildfire danger could travel. Greenbelts can incorporate natural buffer features such as streams or lakes, wetlands (effectiveness dependent upon water level, soil moisture, and other conditions) as well as utility corridors and other managed rights of way.

Establishing greenbelt zones in developing areas may be accomplished through a number of planning vehicles. Transfer of development rights allows landowners to sell or donate their development rights for undeveloped land to a government or organization. Landowners still retain title to the land and can sell it at any time; however the agency retains easement of development. Tax breaks for keeping the land as a conservation area are usually available to landowners. Zoning restriction is another comprehensive approach to area planning, and can specify areas for sensitive land conservation, water quality protection, green space, or fire hazard zones. Zoning can also establish an urban

Figure 11. (Illustration by Marc Foster).

growth boundary. Placing restrictions on urban growth footprints can provide incentives to better infill development and reduce urban sprawl. This is likely to be the most effective approach in the reduction of development in fire-prone areas, and is more legally defensible and enforceable.

Stevenson Ranch in Los Angeles County, California was in the direct path of the 2003 Simi fire, and escaped fire damage while surrounding subdivisions were impacted. This planned development was built to Los Angeles building and fire codes and included a 200 foot wide greenbelt around the subdivision. The maintained greenbelt contained irrigation systems and included fire resistant plants. A Federal Emergency Management Agency (FEMA) report on the fire event noted that the outer greenbelt as well as 100 foot greenbelts between homes enhanced fire protection as well as the use of fire resistant plant materials and fire resistant building materials (FEMA, 2007).

Maintained buffer zones are also credited with wildfire saves for The Bridges, The Crosby, Cielo, Santa Fe Valley and 4S Ranch subdivisions in the 2007 Witch Creek fire in San Diego, California (Weisberg et al., 2007). None of the homes in these five subdivisions were lost while surrounding subdivisions suffered severe damage. One hundred feet of thinned vegetation was required around the structures as mandated by regulation. Maintained greenbelts, or vegetative clearance zones, have also been credited with other saves, including the 6,000 home Tahoe Donner subdivision from the 2007 Truckee fire. A prepared firebreak outside of the residential zone slowed the wildfire to allow firefighters to gain control (McCormich and Russell, 2007).

The Shelter Bay community in Skagit County, Washington was identified as a high fire risk community due its proximity to wildland fuels and surrounding landscape features (Titus and Hinderman, 2007). In addition to the residential area, the community included beaches, recreation areas and greenbelts. Greenbelt tracts make up 25% of the community lands and are of varying acreages. Vegetative management and thinning are conducted within these greenbelt tracts, as well as Firewise® plantings providing for a firesafe wildlife habitat enhancement. In addition to greenbelts creating a fuel break from advancing fires, greenbelts can serve as defensive points for firefighters to set backfires (a fire set along the inner edge of a fireline to consume fuel in the path of a wildfire).

8.2 Firebreaks

Permanent firebreaks may be established into greenbelt areas to provide zones of cleared vegetation. In the 2007 southern California fires, firefighters reported that firebreaks that were created using a bulldozer two lanes wide (18 to 20 feet) were effective to slow wildfire advance (ICTR, 2007). The Florida Department of Environmental Protection recommends firebreaks of 12 to 15 feet wide, dependent upon adjacent fire hazards (State of Florida, 1999). While plowed or disked firebreaks can cause soil erosion and water diversion, vegetated or grazed firebreaks may also be used. Vegetated firebreaks were recommended to be at least 10 feet in width, and maintained through occasional mowing (AFC, 2006). After plowing or disking, seeding is implemented using groundcover species that retard fire or provide enhanced wildlife habitat. Grazed firebreaks provide for livestock feeding and are seeded with bahiagrass, grains, ryegrass or legumes. It was recommended for grazed firebreaks to be at minimum of 16 feet in width (AFC, 2006).

8.3 Roads

Both improved and unimproved roadways have been utilized to stop advancing groundfires or for defensive backfiring. While public roadways outside of developments may serve as firebreaks, the location of interior roads may serve as additional protection. Outer perimeter roads are often used in residential subdivisions and their widths and rights of way can serve larger traffic amounts as well as buffer wildfire. Two lane subdivision roads are often specified at 24 feet in width, which is often wide enough to stop a small advancing grassfire. For areas of higher fire risk, mown rights of way along roadsides will add further fuel clearance. For unimproved access roads the Alabama Forestry Commission recommended that access roads serving as a permanent firebreak be at least 10 feet in width with a maximum grade of 10% (AFC, 2006).

Zeph Cunningham of the National Park Service mentioned that during the Quarry and Peavine wildfires, firefighters successfully used the Blue Ridge Parkway as a firebreak to allow wildfires to burn up to the road, or to backfire from it (Cunningham, 2007). While the road rights of way management along the Blue Ridge Parkway varies along the 470 mile long two lane roadway, vegetation management also varies from between 100 and 500 feet from the road centerline.

8.4 Trails and Walkways

Bike and pedestrian trails may also serve as effective fuel breaks. The South Tahoe Greenway Multi-Use Trail Project will link Meyers, California to Stateline, Nevada (Tahoe, 2006). The bike trail provides a non-motorized alternative transportation corridor through South Lake Tahoe. The trail consists of a 10 foot wide paved path with 2 foot wide cleared shoulders on both sides. To serve as a fire break, forest thinning for fuels reduction will occur within 150 feet from the trail centerline.

A new residential community in Florida, Verandah is a 1,456 acre master planned community in Lee County (Section 9.2). In addition to a number of Firewise® design principles, the incorporated nature trails in the development also serve as additional fuel breaks.

The Ortega Road Fire Break in San Juan Capistrano, California serves as a portion of the Mesa Loop Recreation Trail. This 15 foot wide dirt trail runs for five miles along the outer edge of the Ortega Highway, and allows users to experience the area's sage scrub, grassland, and oak woodland plant communities.

8.5 Cemeteries

Cemetery green space has served to stop previous wildfires. In 1991, Mountain View Cemetery in Oakland, California served as a public refuge from the firestorm in the Oakland hills. Evacuees from the fire gathered in the cemetery with their belongings to watch the fire. With the wide expansive cemetery green space and sprinkler systems, the fire stopped at the cemetery edges.

In some cases, cemetery grounds can help preserve original plant community remnants. Prescribed burning is used to maintain an original stand of tallgrass prairie at Prospect Cemetery Nature Preserve in Paxton, Illinois. Regular fire applications are used around the cemetery as additional defensible space. Many cemeteries utilize mown perimeter firebreaks to prevent any cemetery damage.

8.6 Pastures

The 108 Mile Ranch Community Association in British Columbia, Canada is a residential community that comprises over 1500 acres. In addition to community lakes and golf courses, the development contains an exterior greenbelt used for recreational trails and as a firebreak. The greenbelt is managed for fuel reduction, and also includes extensive horse pastures and an air landing field (108 Mile Ranch, 2008). While pastures may be of various dimensions, they are typically not less than 80 to 100 feet in width, offering a substantial zone of fire protection.

8.7 Airfields

Small landing strips and airfields are amenities provided in some residential subdivisions. For safety and noise reasons, these airstrips are usually located away from main residential areas in the outer greenbelt. Access roads and taxiways at airports make excellent firebreaks. Fifty foot wide mow strips along the edge of runways are not uncommon for small airstrips, which creates a buffer zone exceeding 100 feet in width.

One of the first airparks in the country (1941), the Carmel Valley airport encompasses 25 acres of open space. The airfield served as a firebreak for the surrounding village, and also as an important staging area for fire-fighters and equipment during fire seasons (Vintage Airfield, 2008).

8.8 Utility rights of way and railroads

Utility corridors and railroads can be effective zones for preventing fire spread (NRCS, 2005). Typically these areas are managed for vegetation on a regular basis through the use of prescribed fire, mowing, herbicides or other means. While they may be useful as firebreaks, vegetation management is often conducted along railways to prevent accidental vegetation ignition from the trains. The California Code of Regulations (Title 14) recommends a minimum vegetation control width of 25 feet from railway tracks, which creates nearly 60 feet of wildfire buffer.

8.9 Natural creeks, water bodies, drainage ways

Taking advantage of existing waterways such as creeks, rivers, bays, swamps, and other wetlands as boundaries for developments can be an effective fire break strategy (NRCS, 2005). Similar to other types of fire breaks, the effectiveness of the drainage way depends upon the amount of permanent water within the watershed. Permanent streams at least 15 feet between banks can be effective for stopping small advancing grass fires. Often in riparian corridors the streambank and first terrace vegetation is protected from disturbance,

resulting in older or mature floodplain woodlands. Thick vegetation along streams can transfer fire across small streams, or spot fires can occur from nearby embers.

In the South, seasonal wetlands such as swamps, sloughs, bogs, and floodplains are often saturated with water in winter months, and can be effective fire barriers. In summer, these ephemeral wetlands can dry and become fire prone. As these are ecologically sensitive landscapes, botanists and biologists should first evaluate important plant or wildlife habitats before vegetation management is conducted. Understory thinning, as described below, can help reduce fire risk in wetland areas.

8.10 Shaded fuel breaks

Shaded fuel breaks are areas within woodlands that are thinned or managed to decrease fuel loads. Typically, heavy underbrush (small diameter stems), low limbs, and limb debris up to 8 feet in height are removed which reduces fire intensity and opportunities for crown fires. Generally, closed canopy woodlands have higher humidity levels, lower temperatures, and less wind speeds which helps moderate fire activity, although extreme weather or fire conditions still creates fire danger. Advantages to using woodland shaded fuel breaks include better public acceptance of maintaining forest systems, less occurrence of exotic invasive species becoming established in clearing management, maintaining cooler temperatures on creeks and waterways, and enhanced community use space.

Numerous fire events have proven that shaded fuel breaks can help slow down fire intensity until firefighters can control it. A 1999 wildfire in Winton, California burned 115 acres until the fire reached a shaded fuel break. Fire crews were then able to gain the upperhand before it reached nearby subdivisions. In dense vegetation or high hazard fire areas, fuel breaks of 300 feet in width have been recommended.

Shaded fuel breaks are effective along narrow roadways to expand the defensive zone. A 2003 fire in the Sawmill-Hungry Gulch community east of Bakersfield, California was contained by the prior thinning of roadway vegetation 20 feet on either side of the road.

8.11 Prescribed burn areas

Vegetative buffer zones that are maintained by regularly prescribed fire are also effective ways of mitigating fuel intensity. Grassland fires burn quick and hot, but are of less intensity than dense woodland fires and are easier to control. Maintaining fire management in natural fire ecosystems helps to preserve plant species diversity and certain wildlife populations as well.

A prescribed burn conducted in the Mill Creek Drainage area near Mendocino, California reduced the continuous heavy chaparral and fuel loading. A previous fire in the heavy brush area had burned 26,000 acres and damaged 35 structures. After the prescribed burn, a 2001 fire in the area burned slower and with less intensity and was contained at 10 acres. Tom Crews, USFWS Region 4 Fire Management Officer at Alligator River National Wildlife Refuge in Manteo, North Carolina, relayed that a wildfire in 2000 stopped at a prescribed burn area conducted the previous year. If it were not for the burn management, the main fire could have impacted nearby Manns Harbor Community (Crews, 2008).

Figure 12 (Photo by Bob Brzuszek).

9.0 Recent planned developments for wildfires

Recently developed planned communities in the southeastern U.S. have utilized and incorporated Firewise® design principles. These Florida case studies describe the general layout decisions and community characteristics.

9.1 CASE STUDY #1

Name: RiverCamps on Crooked Creek
Location: West Bay, Florida
Type: Residential community
Development size: 450 homes, 1500 acres
Owner: The St. Joe Company

RiverCamps on Crooked Creek was a planned residential community located outside of Panama City Beach, Florida. This new Firewise community (the first Firewise Community/USA® in the Florida panhandle) was located on previously managed forestry lands owned by The St. Joe Company. Comprising 1500 acres, the development retained the character of Gulf Coastal edge salt marsh and slash pine savanna communities. In the early planning phases, canopy trees were thinned in developable areas to 100 trees per acre.
The Florida Division of Forestry provided wildfire suppression and assistance with prescribed fire throughout the stages of development. The design and management of RiverCamps incorporated a variety of Firewise® strategies, including mechanical thinning and prescribed burn management for a variety of natural habitat types.

Community Layout and Design

Much of the developed residential space takes advantage of wildfire protection from the natural or constructed waterways which surround the community. Protected by Crooked Creek to the east, West Bay on the south, and the Intracoastal Waterway to the west, the primary wildfire hazard area from surrounding forest lands is from the north edge of the development.

The north property edge used a tri-level series of fire protection strategies. The main entry

Figure 13. Master plan for RiverCamps near Crooked Creek (Courtesy of The St. Joe Company).

road to the development was from Highway 388, a two lane county road (100 foot R.O.W.) that runs along the entire north edge of RiverCamps on Crooked Creek, and separated the property from forested lands to the north.

The second level of fire protection inside the north edge road cames from the designated location of fire managed wet pine savanna community. Entitled the 'grass lakes;' this zone of previous slash pine plantation was thinned of dense pine trees and heavy underbrush to create an open grassy understory. For aesthetic purposes, the width of the open pine savanna varied in width from less than 50' to over several hundred feet in portions. Following the clearing of dense pine stands, the site was rollerchopped and prescribed burned. Burns were scheduled at 2 to 3 year intervals to promote naturally occurring grass and wildflower species. Although permanent firebreaks were added in certain defensive areas, the wetland impacts from those firelines required mitigation.

The third level of wildfire protection came from an existing 200 foot wide powerline rights of way. The Gulf Power line ran east-west along the site, with the majority of development on its southern edge. The area was maintained by Gulf Power by the use of herbicides or by mowing to promote a grassland vegetative buffer. Although prescribed fire is currently used at this time, as housing density increases, fuel management may shift to mechanical cutting in all but the permanent mitigation areas (Smith, 2008). Constructed small lakes were scattered through the development as an amenity for housing clusters and also serve as small fuel breaks. Twenty foot wide roads circulate through the development, and while they do not create a classic outer ring road, they primarily serve in the same fashion.

Vegetative management

In addition to the above mentioned fire management of pine savanna environments, periodic thinning of overstory trees and underbrush was scheduled for regular management or remaining plant communities. In designated management zones, salt marsh wetlands were scheduled for periodic burning, and seasonal marshes and upland and lowland pine areas were maintained through a combination of hand thinning and burning. The only unmanaged woodlands were conserved along the western edge of Crooked Creek.

Other Firewise® Community Design Characteristics

RiverCamps on Crooked Creek offered other incorporated Firewise design principles. Two entrances for the development to Highway 388 provided multiple safety routes during emergencies and alternative access for traffic distribution. Utilities were placed underground for fire protection, and fire hydrants were placed at 1,000 foot intervals throughout the development. Additionally, homes were constructed from fire resistant construction materials. Educational materials were provided for residents and Firewise demonstration projects are conducted periodically.

9.2 CASE STUDY #2

Name: Verandah
Name: Verandah
Location: Fort Myers, Florida
Type: Residential community
Development size: 1,456 acres
Owner: The Bonita Bay Group

Verandah is a master planned residential community located in North Fort Myers, Florida. A recognized Firewise Community/USA® residential area, development was previously a cattle ranch operation prior to opening in 2003. Over 1,400 acres in size, the development was recognized by the Florida Association of Realtors with a Residential Environmental Award for preservation of the area's natural elements. Over 70% of the land was retained for open space; and include nature preserves, parks, lakes and riparian conservation buffers. The development included 480 acres of common space and parks, 416 acres of wetland preserves and lakes, 84 acres of upland preserves, and a 25 to 200 foot wide conservation easement along the Orange River waterfront. Over nine miles of walking and bicycle paths were included in the development, which average four feet in width.

All homes in the development must be certified by the Florida Green Building Coalition which encourages energy efficiency, water conservation, indoor environmental quality, and sustainable building materials. To encourage the use of Florida native plants, 70% of a residence's landscape must contain native species.

Community Layout and Design

Similar to RiverCamps, Verandah takes advantage of surrounding features for wildfire protection. The Orange River bordered the south and west edges of the development, offering protection from scattered woodland patches from the south. The riparian zone of the Orange River varied between 100 and 125 feet in width (Fikowski, 2008). Highway 80, a four lane divided highway, bordered the entire north edge property line. The east edge of the property is bordered by Buckingham Road.

An extensive collection of small lakes and ponds were dispersed throughout the development, which maximized the residential waterfront footage, served as emergency water access, and offers extensive fuel breaks. Also dispersed throughout the development were golf fairways which serve as

Figure 14. Master plan for Verandah (Courtesy of The Bonita Bay Group).

narrow green corridors between housing clusters. Nature trails were incorporated into the woodland strips throughout the development, which average 4 feet in width and also serve as fuel breaks.

Vegetative management

Many woodlands at Verandah were conserved as natural areas with minimum vegetative management. A Firewise plant list was distributed to homeowners for use on individual as well as community properties.

Other Firewise Community Design Characteristics

Multiple entrances provide access to the development, and interior roads were 25 feet wide with 5 foot shoulders. All roadway turnaround had radii of 50 feet to accommodate large emergency vehicles. Street signs were constructed from non-combustible materials and were a minimum of four inches in diameter. All the utilities were placed underground to minimize storm and fire damage.

9.3 CASE STUDY #3

Name: Briargate
Location: Ormond Beach, Florida
Type: Residential community
Development size: 60 acres, 89 proposed homes

Briargate was a new developing subdivision within the planned community of Hunter's Ridge, located in the western suburbs of Ormond Beach, Florida. Briargate is a recognized Firewise Community/USA® development on 60 acres of land with 89 planned homesites. The Hunter's Ridge subdivision contained a total of 2,280 homesites, situated in pine forests. Hunter's Ridge subdivision was impacted from three separate wildfires during the 1998 wildfire season which consumed nearly 500,000 acres in central Florida. Although the 1998 fires came within 1/4 of a mile from Briargate, the area that Briargate now encompasses was not directly impacted from the 1998 fires, due to utility rights of way located to the west that was used as a defensible zone. The community was designed with Firewise principles in mind, and developers worked with local fire officials and interested home buyers for input as part of a planning committee. The development contained common green space areas of pine forests and hardwood swamps.

Community Layout and Design

Briargate was bordered along its entire north edge by Airport Road, a two lane paved surface with managed rights of way. This was an important defensive element as woodland fuels are located to the north and west sides of the development. Two means of subdivision entry were provided on this road. Bordering the entire west side of Briargate and Hunter's Ridge was a managed 20 foot wide utility line rights of way. The utility rights of way was in a strategic location, as wildland fires typically occur from the west due to predominantly early and mid-day westerly winds (Garrett, 2008). Hunter's Ridge, an extensive subdivision of homes, was located to the south and east portions. An inner loop road, Briargate Look, was a 24 foot wide road that creates an inner ring of protection to homes, as does Thornhill Circle. Briargate, as well as much of Hunter's Ridge, used ponds located in strategic locations to mitigate water runoff as well as provide defensive fire zones. Many of the ponds were oriented in a north/south direction, as were many of the interior Hunter's Ridge development roads, which offered further protection from fires occurring from the west.

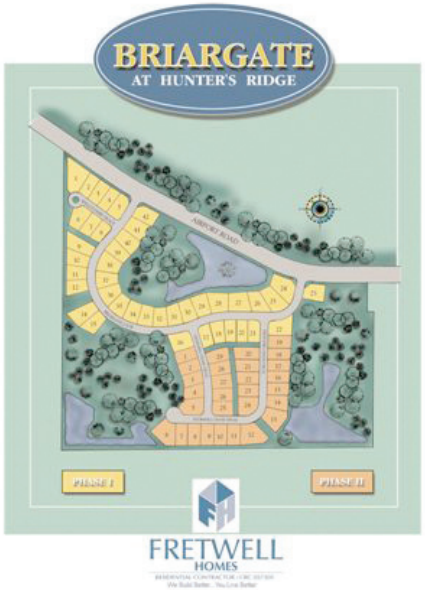

Figure 15. Briargate Community Plan (Courtesy of Fretwell Homes).

Developers of Briargate saw an opportunity to save on expenses associated with site preparation while creating a Firewise community. Briargate, as well as surrounding woodland areas, were thinned of trees to 100 trees per acre, which the developer sold for additional income, as well as being managed for willand fuels. Additionally, development costs were mitigated by the reuse soil excavated from the ponds to be reused in the development. The reuse of soil combined with an agreement to extend buildout timelines for multiple lot development saved the developer from a significant expense of hauling the soil offsite.

Vegetative management

Firewise landscaping was required within 30 feet of all structures at Briargate. This includes tree locations at a minimum distance of 30 feet from structures as well as other trees. Fire resistant species were required, as are irrigation systems within the 30 foot zone. Property owners and the association were responsible for the ongoing maintenance of vegetation within the wildfire protection zone. A management plan was required and approved by the city.

Other Firewise Community Design Characteristics

Briargate utilizes a number of Firewise community principles. The community has underground utilities to prevent damage to lines during wildfires and storms, has a million gallon water tank for firefighting, pressurized fire hydrants with rating of 200 gallons per minute, and conducts regular Firewise community meetings.

9.4 Summary of Firewise planned communities

The design and layout of all three case study Firewise design communities revealed similar techniques for incorporating existing fuel breaks and designing maximum managed buffer space around the development. Although these developments have not yet been tested by a wildland fire, the lessons learned from the design of these communities include:

1. Take advantage of existing creeks and waterbodies as property edges for the development where possible. As shown at RiverCamps and Verandah, these riparian buffers form extensive fire breaks for protection, with no cost for installation or management. The location of the main developments at RiverCamps took best advantage of water protection on three sides of the subdivision, as well as providing community amenities. Orange Creek at Verandah also formed a large property buffer for this community. It was not recommended to widen existing perennial streams due to ecologic and hydrologic disruption. Intermittent streams, hardwood swamps or drainage corridors can utilize shaded fuel break strategies of thinning riparian edges to reduce fire hazards in dry seasons or low humidity conditions. Thirty to 100 feet of vegetation management in these zones will reduce the fuel load risk. As shown in the 1998 Flagler fire, existing waterbodies can stop advancing wildfires.
2. Utilize existing roadways along development edges. All three developments wisely utilize major or minor collector roads as a defensive space. As with creeks, these existing firebreaks added no cost to the development or its continued management. A minimum of two lanes width (24 feet) with managed rights of way (minimum 10 feet) was recommended for roadways.
3. Use existing utility corridors as property edge boundaries or as interior defensible space for housing locations. As evidenced in the 1998 wildfire at Hunter's Ridge, managed utility rights of way can be valuable defensible zones. Briargate and RiverCamps took advantage of these existing narrow corridors to locate their developments along the inner edge for further protection. Utility rights of way provided additional green space and incorporated into the larger community open space plan. While utility companies typically maintain the rights of way (R.O.W.), communities may provide recommendations for the types of vegetation management and suggested R.O.W. widths. Thirty foot wide corridors were the recommended minimum width for rights of way.
4. Develop new ponds, lakes, wetlands, and other drainage features into the community. All three developments contain newly created waterbodies dispersed throughout the subdivisions. Waterfront properties or community common areas were highly marketable amenities for residential sales, and offer numerous other benefits. Developing retention or detention ponds assist in stormwater management by collecting and treating residential runoff. Ponds also allow for better infiltration into ground aquifers and reduce runoff pollution in local waterbodies. Stormwater ponds may reduce flooding potential in low lying areas, and if managed properly offer additional wetland wildlife habitat. As shown in Hunter's Ridge subdivision, orienting subdivision waterbodies along the width of potential wildfire directions may prove an effective defensive measure. Retention ponds also offer firefighters another source of water in a community during fire operations. A grassland or managed woodland buffer strip (30 feet wide) around water bodies will help trap sediments and filter nutrients before reaching the water body.
5. Consider using outer loop roads within the community property. Briargate's use of 24 foot wide loop roads with managed rights of way offer increasing zones of protection for structures from offsite wildfires. Though not a loop road per se, RiverCamps extensive outer road systems serve the same function. As shown in the 1998 Brevard County, Florida fire, large roads and increased road densities were effective at stopping wildfires.
6. Place managed open space amenities along the outer edge of developments. Verandah's

use of golf course fairways along the periphery of the development, as well as in the interior of the development, offer a good community use while offering fire protection. RiverCamps extensive pedestrian trail systems act as additional firebreaks in both woodland and savanna areas, and provide access to important amenity use points along the Bay.

7. Provide managed vegetative buffer zones along property edges, especially adjacent off-site wildland fuel areas. Briargate's thinned woodland along the western property edge was an important wildfire fuel mitigation buffer and a community amenity. Having routine management of the woodland buffers was important to include in the community homeowners association covenant. Design and location of the open savanna grassland areas at RiverCamps provided an important buffer from neighboring wildland fuels. The continued use of prescribed fire in this area and thinning of adjacent woodlands were important management goals to reduce wildfire fuel loads.
8. Maximize the number of Firewise community defensive strategies. All three developments use a number of Firewise design principles that address multiple fire risks, ranging from vegetative management to building and road standards. NFPA 1144, NFPA 1141, and the Wildland Urban Interface Code provide a comprehensive list of factors to consider for developing effective Firewise developments. As shown in the 1998 Florida fires, multiple, smaller defensible zones were effective strategies for stopping wildfires. Firewise development does not guarantee prevention from wildfire damage, but lessens the potential impact or severity through multiple measures.
9. Create and concentrate high density areas of development instead of low density to minimize the developable footprint. As displayed in the 1998 wildfires in Flagler County, Florida, wildfires stopped at the transition from low density to medium and high density areas. The development and enforcement of plans and ordinances that prevent development in areas known to be at high risk of catastrophic wildfire, or at a minimum that require compact, defensible development, is the best approach to new development.
10. Catastrophic wildfire prevention is only possible at the regional planning level, and not necessarily at individual site levels. The 1998 Florida fires occurred in large roadless areas of heavy fuels. Fuel management to prevent large wildfires occurred at a large landscape level. As utilized in California, high hazard areas of wildfire risk and other potential natural disasters should be identified in regions. Regional planning allows for the best utilization of transportation, economic development, environmental protection, utility corridor locations, climactic and wind patterns, and site selection for safest developable areas.
11. Work with local fire officials and community stakeholders in the early planning phases. Cooperation between the Florida Division of Forestry and the developers resulted in an extensive mitigation effort prior to property planning at RiverCamps. The planning advisory board at Briargate included local fire officials, homeowners, and the developer to create strategies for wildfire control and community amenities. The inclusion of community fire officials allowed for variances to development, resulting in significant cost savings.

Summary

Wildfire experts suggest three simple approaches to developing within the WUI: 1) design developments that are easy to defend against wildfire, 2) design fire-resistant landscapes and structures, and 3) design developments that incorporate ongoing fuel reduction treatments to reduce vegetative hazard.

Effective development design steps to reduce fire risk include:

1. For a proposed development area, review existing municipal or county regulatory fire codes.
2. An evaluation of fire risk from surrounding properties and their environments. This may be accomplished by contacting your local fire official for an inspection of the area or your state Firewise coordinator. Identify zones that may need protection that abut vegetative fuel areas and complete a risk

assessment checklist. Review the history of wildfire occurrence in the area.

3. An identification of zones on the property that will offer possible wildfire protection, including existing roadways, railways, utility rights of way, creeks or drainage features, or cleared areas.
4. The development of strategies for wildfire protection from possible fire areas. These may include the design and placement of roads with cleared rights of way, or other green space options listed in Section 8. Design multiple ingress and egress roads for developments that accommodate access by large emergency vehicles. An identification of drainage areas on the property and location of open green space in these areas to serve as water quality buffers.
5. The clustering of development into areas that take advantage of the most protected zones.
6. Proposed development layouts reviewed by fire officials.
7. An assessment of the existing vegetation conditions and conduct fuel management practices prior to construction.
8. An incorporation of Firewise design principles into the properties and building construction materials.
9. The development of fuel management plans for vegetated areas and maintenance schedules. Make sure these are conducted regularly. Have local fire officials inspect development common areas and residential properties for assessment.
10. The nomination of your development for Firewise Community/USA® recognition. Distribute wildfire education materials to homeowners and alert them to safe Firewise practices on their property. Educate homeowners on the Firewise design and management for the development, including the values of prescribed burning practices or water quality management practices that are being used. Residents will better accept smoke management, savanna landscapes, or buffer zone management when alerted to the important environmental values associated.

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11.0 Additional Resources

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State Firewise Coordinators are administered through state forestry commissions. For assistance with Firewise® information, contact your state forestry commission.